PHOSPHORUS-DEOXIDISED COPPER (HIGH RESIDUAL PHOSPHORUS)

Cu-DHP

Commercially-pure copper which has been deoxidised with phosphorus to leave a relatively high residual content. It is not susceptible to hydrogen embrittlement. The conductivity of this type of copper is relatively low on account of the high phosphorus content. The raw material is normally available as cakes, slabs and billets which are hot and cold worked into wrought forms.

COMPOSITION (weight %)

Cu (+ Ag)	99.85 min.
P	0.013 - 0.050

1 SOME TYPICAL USES

Architectural and Building:

Tubes for hot and cold water services, gas and heating installations, both buried and above ground; soil and waste pipes; storage tanks, cisterns and cylinders; air conditioners.

Mechanical:

Suitable for any equipment involving heating in reducing gases either during joining processes or in service; evaporator and heat exchanger tubes; steam, air, water and oil lines; automobile radiators.

Chemical:

Stills, vats, autoclaves and general coppersmithing involving welding; tubes for relatively non-corrosive liquids and gases and for refrigeration.

Electrical:

Anodes for electroplating and electroforming from acid sulphate baths.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.9 g/cm³	0.321 lb/in³
2.2	Melting point	1 083 °C	1 981 °F
2.3	Coefficient of thermal expansion (linear) at:		
	— 253 °C *— 423 °F* (1)	0.000 000 3 per °C	0.000 000 17 per °F
	— 183 °C *— 297 °F* (1)	0.000 009 5 » »	0.000 005 28 » »
	— 191 to 16 °C *— 312 to 61 °F* (2)	0.000 014 1 » »	0.000 007 83 » »
	25 to 100 °C *77 to 212 °F* (2)	0.000 016 8 » »	0.000 009 33 » »
	20 to 200 °C *68 to 392 °F* (3)	0.000 017 3 » »	0.000 009 61 » »
	20 to 300 °C *68 to 572 °F* (4)	0.000 017 7 » »	0.000 009 83 » »
2.4	Specific heat (thermal capacity) at:		
	— 253 °C *— 423 °F* (2)	0.003 1 cal/g °C	0.003 1 Btu/lb °F
	— 150 °C *— 238 °F* (2)	0.067 4 »	0.067 4 »
	— 50 °C *— 58 °F* (2)	0.086 2 »	0.086 2 »
	20 °C *68 °F* (2)	0.092 1 »	0.092 1 »
	100 °C *212 °F* (2)	0.093 9 »	0.093 9 »
	200 °C *392 °F* (2)	0.096 3 »	0.096 3 »
2.5	Thermal conductivity at:		
	20 °C *68 °F*	0.70 - 0.87 cal cm/cm² s °C	169 - 211 Btu ft/ft² h °F

continued overleaf

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 10); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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DATA SHEET No. A 6
Cu-DHP

2 PHYSICAL PROPERTIES (continued)

	Metric Units	English Units
2.6 Electrical conductivity (volume) at:		
20 °C *68 °F* (annealed or cold worked)	41 - 52 m/ohm mm²	70 - 90 % IACS
2.7 Electrical resistivity (volume) at:		
20 °C *68 °F* (annealed or cold worked)	0.025 - 0.019 ohm mm²/m 2.5 - 1.9 microhm cm	15 - 12 ohms (circ mil/ft) 0.97 - 0.75 microhm in
2.8 Temperature coefficient of electrical resistance at: (a)		
20 °C *68 °F* (annealed or cold worked)	0.002 75 per °C (70 % IACS)	0.001 53 per °F (70 % IACS)
applicable over range from 0 to 100 °C *32 to 212 °F*	0.003 54 » » (90 % IACS)	0.001 96 » » (90 % IACS)
2.9 Modulus of elasticity (tension) at 20 °C *68 °F*:		
annealed	12 000 kg/mm²	17 000 000 lb/in²
cold worked	12 000 - 13 500 »	17 000 000 - 19 000 000 »
2.10 Modulus of rigidity (torsion) at 20 °C *68 °F*:		
annealed	4 500 kg/mm²	6 400 000 lb/in²
cold worked	4 500 - 5 000 »	6 400 000 - 7 000 000 »

(a)— The temperature coefficients of resistance given can be used for calculating resistances within the temperature range shown, but these relate only to calculations based on a reference temperature of 20 °C *(68 °F)*.

— The temperature coefficient of resistance of copper can be assumed to be directly proportional to the conductivity value and the figures given above have been calculated on the basis that copper of 100 % IACS conductivity at 20 °C *(68 °F)* has a temperature coefficient of resistance of 0.003 93 per °C *(0.002 18 per °F)*. Temperature coefficients of resistance for copper with a conductivity value within the range shown above may be calculated in the same manner.

3 FABRICATION PROPERTIES

The information given in this table is for general guidance only, since many factors influence fabrication techniques.

The values shown are approximate only, since those used in practice are dependent upon form and size of metal, equipment available, techniques adopted and properties required in the material.

	Metric Units	English Units
3.1 Casting temperature range	1 140 - 1 200 °C	2 085 - 2 190 °F
3.2 Annealing temperature range	250 - 650 °C	480 - 1 200 °F
Stress relieving temperature range	200 - 250 °C	390 - 480 °F
3.3 Hot working temperature range	750 - 950 °C	1 400 - 1 750 °F
3.4 Hot formability	Good	
3.5 Cold formability	Excellent	
3.6 Cold reduction between anneals	95 % max.	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free-cutting brass = 100)	20	
3.8 Joining methods:	See General Data Sheet No. 3.1	
Soldering	Excellent	
Brazing	Excellent	
Oxy-acetylene welding	Good	
Carbon-arc welding	Good	
Gas-shielded arc welding	Excellent	
Coated metal-arc welding	Not recommended	
Resistance welding: spot and seam	Fair	
butt	Good	

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE [a]

5.1.1 Typical Tensile Properties and Hardness Values - Metric Units

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation below or above the typical values indicated.

Form	Temper	Tensile Strength kg/mm²	Proof Stress 0.2 % offset kg/mm²	Elongation		Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown [b]
				%	gauge length	Brinell	Vickers		
Plate Sheet Strip	Annealed	22	5	48	$5.65\sqrt{S_o}$	45	50	16	—
	Hot Rolled	23	8	40	$5.65\sqrt{S_o}$	55	60	16	—
	Typical Cold Worked Tempers	27	18	25	$5.65\sqrt{S_o}$	75	80	18	0.2 - 10 mm thick
		32	27	12	$5.65\sqrt{S_o}$	90	100	19	0.2 - 6 mm thick
		38	34	6	$5.65\sqrt{S_o}$	105	115	20	0.2 - 1.5 mm thick
Rod	Annealed	22	5	45	$5.65\sqrt{S_o}$	45	50	18	—
	Typical Cold Worked Tempers	28	19	20	$5.65\sqrt{S_o}$	75	80	18	6 - 40 mm diam. or up to 1 250 mm² area
		34	28	10	$5.65\sqrt{S_o}$	95	105	19	6 - 20 mm diam. or up to 300 mm² area
Tube	Annealed	24	6	45	$5.65\sqrt{S_o}$	45	50	16	—
	Typical Cold Drawn Tempers [c]	**27**	**18**	**30**	$5.65\sqrt{S_o}$	**75**	**80**	**18**	10 - 200 mm O.D. up to 10 mm wall
		32	**27**	**15**	$5.65\sqrt{S_o}$	**90**	**100**	**19**	10 - 100 mm O.D. up to 6 mm wall
		35	30	8	$5.65\sqrt{S_o}$	100	110	20	10 - 50 mm O.D. up to 2 mm wall
		38	35	6	$5.65\sqrt{S_o}$	105	115	20	up to 25 mm O.D. up to 1 mm wall
Forgings	Hot Worked	23	6	35	$5.65\sqrt{S_o}$	50	55	16	—
Sections / Shapes	Hot Worked	24	8	35	$5.65\sqrt{S_o}$	50	55	16	—
	Typical Cold Worked Tempers [d]	27	18	20	$5.65\sqrt{S_o}$	75	80	18	—
		32	27	10	$5.65\sqrt{S_o}$	90	100	19	—

(a) It will be noted that tables 5.1.1, 5.1.2 and 5.1.3, giving typical tensile properties and hardness values in Metric, English and American units, respectively, are not directly comparable. This is because the properties quoted reflect to some extent the metalworking techniques and specification practices of the countries concerned.

(b) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal suppliers.

(c) Tubes for condensers and heat exchangers are generally supplied only to the tempers whose representative mechanical properties are printed in **bold type.**

(d) The mechanical properties will be largely dependent upon the complexity and cross-section of the product.